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Sommario

Mobile robots are increasingly being employed to assist responders in search and rescue missions. Robots have to navigate in dangerous areas such as collapsed buildings and hazardous sites, which can be inaccessible to humans. Tele-operating the robots can be stressing for the human operators, which are also overloaded with mission tasks and coordination overhead, so it is important to provide the robot with some degree of autonomy, to lighten up the task for the human operator and also to ensure robot safety. Moving robots around requires reasoning, including interpretation of the environment, spatial reasoning, planning of actions (motion), and execution. This is particularly challenging when the environment is unstructured, and the terrain is extit{harsh}, i.e. not flat and cluttered with obstacles. Approaches reducing the problem to a 2D path planning problem fall short, and many of those who reason about the problem in 3D don't do it in a complete and exhaustive manner. The approach proposed in this thesis is to use rigid body simulation to obtain a more truthful model of the reality, i.e. of the interaction between the robot and the environment. Such a simulation obeys the laws of physics, takes into account the geometry of the environment, the geometry of the robot, and any dynamic constraints that may be in place. The physics-based motion

planning approach by itself is also highly intractable due to the computational load required to perform state propagation combined with the exponential blowup of planning; additionally, there are more technical limitations that disallow us to use things such as state sampling or state steering, which are known to be effective in solving the problem in simpler domains. The proposed solution to this problem is to compute heuristics that can bias the search towards the goal, so as to quickly converge towards the solution. With such a model, the search space is a rich space, which can only contain states which are physically reachable by the robot, and also tells us enough information about the safety of the robot itself. The overall result is that by using this framework the robot engineer has a simpler job of encoding the extit{domain knowledge} which now consists only of providing the robot geometric model plus any constraints.

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